



# RU S3\_06: Fast evaluation of parameters and effects of strong earthquakes: a synthesis of first year results



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## REAL TIME SEISMOLOGY

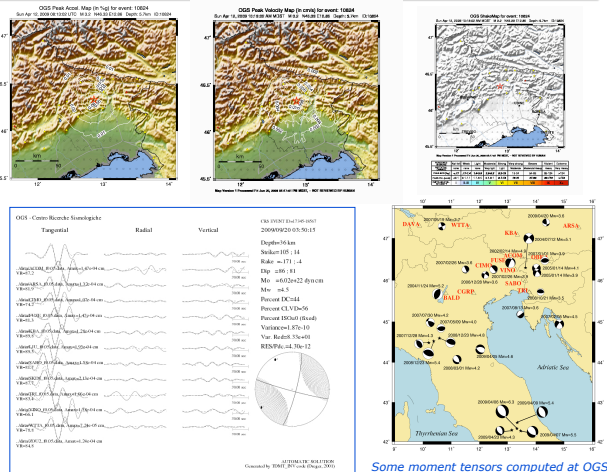


### Shakemap

ShakeMap software (Wald et al., 2006) customized for Italy by INGV has been installed at OGS and efforts have been made for ensuring the coherency with the maps of ground-motions computed at other Italian data centers for the same earthquake.

### Moment tensor

We tuned for NE Italy the TDMT\_INV code (Dreger, 2001). Several tests, have been performed to check the sensitivity of solutions to the CRS broadband network geometry, to the number of stations as well as to the 1D velocity models used. Our tests revealed that the best double couple and the Mw are quite robust and that one or two-station solutions can be effective in many cases. The automatic procedures is activated for the earthquakes  $M_I > 3.6$  located in NE Italy and surroundings.

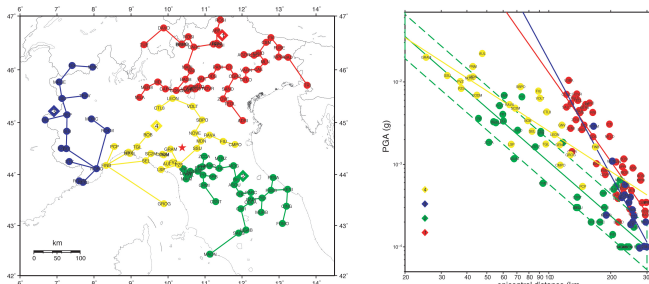


Some moment tensors computed at OGS

## RESEARCH ON SHAKEMAP

### Shakemap validation

We have assessed the impact of regional and site characteristics on the uncertainty of ground-motion predictive equations available for Italy. Using INGV data we proved that site conditions contribute to about 30% of such uncertainty, while regional characteristics contribute for less than 4%, with major differences (higher acceleration for the same magnitude and distance from the source) located in north-eastern Italy (Bragato 2009).



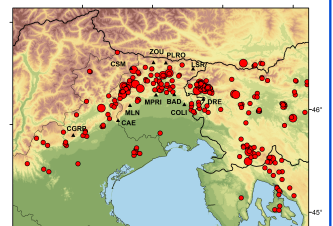
PGA recorded for the 2008/12/23 Parma earthquake ( $M_w=5.4$ ). The solid lines of right panel represent the regression curves estimated for different Italian regions. The dashed lines indicates +/- one standard deviation (0.25) associated to the green line (attenuation along the Apennines). NE PGA values are 4 times greater than the corresponding values observed along the Apennines.

### Site conditions

To study the near surface attenuation we have determined the spectral decay parameter  $k$  of 302 earthquakes ( $3.0 \leq M_0 \leq 5.6$ ) recorded by OGS network during 1994-2007.

The logarithm of the acceleration spectrum of strong-motion data exhibits a linear trend with frequency over the corner frequency of the event and characterized the linear decay by the spectral decay parameter  $k$ .  $k$  is related to the epicentral distance, subsurface geological structure beneath the station-site and on horizontal S-wave propagation through the crust.

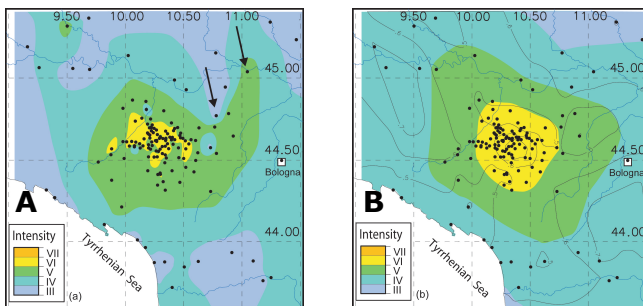
The estimated slope ( $k_1 = 0.00013$  s/km) is consistent with high-frequency  $Q_s$  values in Eastern Alps and can be explained assuming a quality factor  $Q$  ( $f > 10$ Hz) ranging between 2120 and 2310.



Acceleration spectra (EW component) of two events of the Kobarid 1998 sequence recorded at Bernadia station in NE Italy.

### The KF technique as GMPE in ShakeMap

We tested if the KF formula (Sirovich and Pettenati, 2009) could be used inside ShakeMap as a new type of ground motion prediction equation, which includes source effects. This could be useful mostly for moderate earthquakes in areas with few instrumental data.

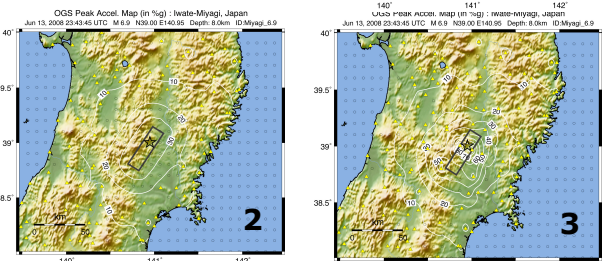


Observed (A) and forecasted (B) intensities for the 2008/12/23 Parma earthquake ( $M_w=5.4$ ). (A)  $N-N$  contour map of the macroseismic intensities (MCS) collected by the QUEST team (black dots). (B) the mean KF parametric scenario and standard deviation (thin solid lines). The acceptable fit (that would increase considerably omitting the two sites shown by the arrows in A) was obtained without considering the geological nature of the sites and reveals that the KF formula is promising for improving existing rapid algorithms.

### The source effects on ShakeMap

Jointly with INGV S3 RUs, we studied the 2008 Miyagi earthquake  $M_w=6.9$ , chosen as target event for its optimal data coverage. We evaluated directivity effects and whether synthetic seismograms generated with finite-fault model can be used in place of (or as an integration to) GMPEs within the ShakeMap methodology.

- 1) ShakeMap using all real data
- 2) ShakeMap using real data  $Repi > 50$  km
- 3) ShakeMap using real data  $Repi > 50$  + synthetic seismograms



## ACKNOWLEDGMENTS

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